

Original Communication

Significant increases in body mass indexes (BMI) in an adult autopsy population from 1986 to 2006 – Implications for modern forensic practice

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Abstract

A study was undertaken of two coronial autopsy populations aged ≥ 17 years in Adelaide, South Australia in 1986 and in 2006 to determine whether there had been any increase in body mass index over the intervening 21 years. In 1986 there were 689 cases; M:F = 2.8:1. The average BMI was 25.1, with a range from 12.5 to 55.5. 47% of cases had a normal BMI (18.5–24.9), 14.8% were obese (BMI ≥ 30), with a subset of 1.3% of cases classified as morbidly obese (BMI ≥ 40). In 2006 there were 1176 cases; M:F = 1.9:1. The average BMI was 27.1 with a range from 10.5 to 80.6. 32.1% of cases had a normal BMI, 27.2% were obese, with a subset of 4.8% of cases classified as morbidly obese. This study has confirmed that there has been a marked relative and absolute increase in numbers of obese individuals undergoing coronial post-mortem examinations in South Australia, with 218 more autopsies in 2006 involving obese bodies, including 47 more cases where morbid obesity was documented. This trend is undoubtedly occurring in other countries. Significant problems exist in trying to handle obese and particularly morbidly obese individuals in mortuaries designed for bodies with normal BMIs. Lifting, transport, transfer, storage and autopsy dissection are all difficult. Obesity enhances putrefaction that further complicates handling. Unless mortuaries are modified to deal with the increasing numbers of morbidly obese individuals, with reinforced and robust equipment including lifting hoists, the autopsy examination of such cases may be compromised, and staff will be confronted with ongoing and increasing risk of injury.

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1. Introduction

In recent years there has been increasing awareness of obesity as a major health problem.^{1,2} The World Health Organisation estimates that there are approximately 1 billion people overweight globally and that figure will increase to 1.5 billion by 2015 if current trends continue.³ In the

United States there was an increase in prevalence of morbid obesity from 0.78% to 2.2% between 1990 and 2000, with an estimated 4.8 million morbidly obese individuals in that country alone in 2000.⁴ This represents 1 in 20 Americans.¹ It has also been shown that the prevalence of morbid obesity (body mass index, BMI ≥ 40) is increasing at twice the rate of simple obesity.⁵ Considerable attention has been paid to the health consequences of this ‘epidemic’ for obese individuals in terms of reduced life expectancy and increased risks of cardiovascular disease, diabetes mellitus and certain malignancies.⁶ There has also been a significant increase in medical expenditure related to the increase in obesity.^{4,7}

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Although it is recognised that the number of obese individuals both in the community and presenting to health care facilities has increased significantly in recent times, less attention has been paid to the effects of this trend in the mortuary environment.⁸ Following a series of autopsies on large individuals at the end of 2006 and the beginning of 2007, a pilot study was undertaken which indicated that there had been an increase in BMI in individuals undergoing coronial autopsies in South Australia over the past two decades.⁹ To investigate this further, a larger study was undertaken to compare BMIs in males and females examined at autopsy in 1986–2006, and to analyse the possible implications that any changes identified may have for routine autopsy practice and workplace safety.

2. Materials and methods

Review was undertaken of autopsy files at Forensic Science SA from January 1st to December 31st, 1986, and from January 1st to December 31st, 2006 for all individuals aged older than 16 years (≥ 17 years). Information was obtained on the age, sex, height and weight of bodies. Cases were not included in the study if the height, weight, age or sex had not been recorded, or if there had been significant disruption of the body with loss of body parts or organs, for example after an explosion, trauma, incineration, putrefaction or post-mortem animal activity, that had resulted in artefactual changes to the height and weight. Measurements of body lengths were all crown-heel lengths taken by mortuary staff using standard rulers with bodies in the supine position. Weights were recorded on the same set of calibrated scales for all cases with the bodies either naked or only lightly clothed. Case details were summarized and the body mass indexes (BMIs) were calculated using the standard formula of weight in kilograms divided by the height in metres squared.¹

3. Results

(1) Between January and December 1986 there were 689 individuals over the age of 16 years included in the study, with a male to female ratio of 2.8:1. There were 506 males with an age range of 17–95 years. The average BMI for the males was 25.3, with a range of 12.5–55.5. 234/506 cases (46.3%) had normal weights (BMI 18.5–24.9) and 70/506 (13.8%) were obese (BMI ≥ 30), including a subset of 7/506 cases (1.4%) with morbid obesity (Class III; BMI > 40).

There were 183 females with an age range of 17–94 years. The average BMI was 24.7, with a range of 12.5–55.2. 90/183 cases (49.2%) had normal weights and 32/183 (17.5%) were obese, including a subset of 2/183 cases (1.1%) with morbid obesity.

(2) Between January and December 2006 there were 1176 individuals over the age of 16 years, with a male to female ratio of 1.9:1. There were 763 males with an age range of 17–96 years. The average BMI was 27.6, with a range of 12.2–80.6. 240/763 cases (31.5%) had normal

Table 1

Summary of BMI and weight data from 1986 and 2006 in a South Australian coronial autopsy population

	1986	2006
Number of cases	689	1176
Average BMI	25.1	27.1
Average weight (kg)	69.8 \pm 9.8	77.4 \pm 14.5
BMI range	12.5–55.5	10.5–80.6
Normal weight (BMI 18.5–24.9)	<i>N</i> = 324 (47%)	<i>N</i> = 378 (32.1%)
Obese (Classes I–III; BMI ≥ 30)	<i>N</i> = 102 (14.8%)	<i>N</i> = 320 (27.2%)
Morbidly obese (Class III; BMI ≥ 40)	<i>N</i> = 9 (1.3%)	<i>N</i> = 56 (4.8%)
4 heaviest bodies	137, 137, 148, 175 kg	178, 201, 226, 236 kg
4 largest BMIs	44.7, 48.3, 55.2, 55.5	65.4, 66.0, 78.5, 80.6

weights and 214/763 (28%) were obese, including a subset of 32/763 cases (4.2%) with morbid obesity.

There were 413 females with an age range of 17–98 years. The average BMI was 26.2, with a range of 10.5–78.2. 138/413 cases (33.4%) had normal weights and 106/413 (25.7%) were obese, including a subset of 24/413 cases (5.8%) with morbid obesity.

Given the similarity in trends between the male and female groups with no consistent gender differences being demonstrated in either year, the data were combined to give an overview of the differences between total numbers of cases from 1986 to 2006. These are summarized in Table 1.

4. Discussion

The current study has confirmed that there has been a marked increase in the number of obese individuals undergoing coronial post mortem examinations in South Australia over the past 21 years. An increase in BMI was also shown in a 51-year retrospective study of autopsy weights in the United Kingdom from 1947 to 1997.⁸ While an increase in the average yearly BMI from 25.1 in 1986 to 27.1 in 2006 in South Australia may not appear particularly significant, closer examination reveals that there has been a 14.8% decline in individuals of normal size from 47% to 32.2%, with a 12.4% increase in obese individuals from 14.8% to 27.2% (Table 1). In the subset of morbidly obese individuals, with BMIs of 40 and above, there has been a 3.5% increase from 1.3% to 4.8%. Importantly, these increases are not only relative, but also absolute. For example, in 2006 there were 218 more autopsies involving obese bodies than in 1986, including 47 more where morbid obesity was documented. It is also not only the number of obese bodies that is increasing, but the sizes of the bodies as well; for example, the four largest bodies in 2006 all weighed more than the heaviest body in 1986.

It is recognised that obese individuals are presenting increasing problems in other areas of health care. Larger ambulances are being required to transport these people to hospital and there are then considerable difficulties with

internal transport and accommodation. Clinical investigations ranging from simple venesection to complex imaging are being made more difficult by increasing patient size.¹⁰

The problem with increasing numbers of deceased individuals of large mass is that mortuaries were generally designed to deal with bodies of normal size. Morbidly obese individuals often do not fit into standard refrigeration bays and they are often exceedingly difficult to move onto trolleys designed for bodies with normal BMIs. Lifting or transferring such bodies may place mortuary staff at considerable risk of back injury, and handling of the deceased often lacks dignity due to the great difficulties that arise in physically positioning these bodies. Pathologists and technicians often have difficulty in performing autopsy dissections, as opening body cavities that are encased in many centimetres of adipose tissue is technically difficult and sometimes not possible on standard trolleys or tables. Autopsies have been performed on floors, or with a pathologist leaning from a ladder, or actually standing on the trolley over a body. Moving bodies from one trolley to another, as may be required in some mortuaries, is a potentially dangerous activity with the possibility of injury to staff who are lifting excessive weights. There is always the danger of dropping the body.

Obese bodies also present problems other than handling their weight, as large body masses enhance putrefactive processes. Once purging with skin blistering and slippage occurs, these bodies become slippery, making handling even more difficult. Description of wounds and injuries in suspicious cases or homicides may also be quite difficult if bodies cannot be easily moved to clearly demonstrate all skin surfaces. The implementation of standard specialised barrier autopsy procedures may not be possible if HIV or other significant infections are present.

The need for an autopsy to determine a cause of death in someone with morbid obesity may be questioned. Unfortunately although there is an increased risk of hypertension, diabetes, cancer, cerebrovascular and ischaemic heart disease, clinical evaluation may have been suboptimal due to the large size of the deceased, and morbid obesity may be something that the deceased has died with, and not from. Attending doctors may not have been able to confirm

or refute intra-abdominal disease clinically as it may not have been possible to find an operating room that could accommodate such a patient, even if the associated anaesthetic risks could have been successfully managed. Similarly, it may be impossible to exclude a pulmonary embolus until after autopsy. Obese individuals are also at increased risk of the effects of sepsis.¹¹ Thus, autopsies are often required to determine precise causes of death, despite the possible range of lethal diseases present.

In summary, unless adequate mortuary facilities are available, with equipment specifically designed to deal with obese and particularly morbidly obese individuals undergoing medicolegal autopsies, adequate examinations may not be possible and staff may not be able to deal with the increasing numbers of such cases due to the very real risk of injury. The greater numbers of morbidly obese bodies in coronial practice raises very significant occupational health and safety issues for mortuary staff.

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